CASE STUDY: Improved solar forecast model supporting services for the South Africa energy sector

Executive Summary: The Weather and Climate Science for Service Partnership (WCSSP) South Africa project has improved renewable energy forecasting by the South African Weather Service (SAWS) through developing an innovative machine learning-based solar forecast model that is improving SAWS services to energy operators, supporting better balancing of electricity supply and demand, supporting a more resilient and reliable power network. Through collaboration, technology transfer, and training, the programme has strengthened South Africa's capacity to integrate renewable energy, reduce the impacts of load shedding, and support long-term energy security, while also advancing UK expertise in AI-driven weather and energy forecasting.

The Challenge: South Africa is currently experiencing a mismatch between electricity demand and supply, resulting in frequent load shedding events, where electric power in parts of the power-distribution system is deliberately shutdown when demand threatens to exceed supply in order to prevent the failure of the entire system. The stress on the energy sector is expected to be further exacerbated by the impacts of climate change resulting in detrimental impacts on energy-intensive industry sectors that are crucial for the South African economy. Building a resilient energy network is therefore important from both an economic and environmental perspective, and reliable renewable energy production forms a crucial element of this network. The South African Department of Energy has committed to achieving 40% renewable energy by 2030, with plans that a third of this supply will come from solar energy.



Solar panels on an off the grid electricity installation on a farm in the Karoo outside Touwsrivier in the western cape of South Africa

The Approach: Work under the Weather and Climate Science for Service Partnership (WCSSP) South Africa has previously co-developed with the South African Weather Service (SAWS) site-specific solar radiation forecasts for predicting solar power. These forecasts have supported energy system



Generic image depicting energy generation and fluctuation.

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operators to optimally dispatch solar and other energy sources to balance the generation and demand and enable the electric grid to be more flexible and adapt to changing conditions as well as minimize disruptions.

Pathway to Impact: Building upon this success, new work over the past 12 months has developed a prototype machine learning (ML) solar forecast model to better inform the renewable energy sector. This novel application of existing openly available ML tools has been shown to perform as good or even better than the traditional more expensive approach of running a physical numerical weather model for solar forecasting. This prototype model has been delivered to SAWS along with training of staff to support its use in forecasting for the solar energy sector. It will enable energy system operators to optimally dispatch solar and other energy sources to balance the generation and demand and enable the electric grid to be more flexible and adapt to changing conditions as well as minimize disruptions.

The learnings from the development of this prototype can be applied to wider meteorological data and geographic regions, and work is currently ongoing around the possible applications of ML for wind energy forecasting, to support both the South African and UK energy sectors. Improved decision making around energy security is paramount to support South Africa's industry and socio-economic growth and is of growing importance in the UK towards Net Zero ambitions. It will allow for better preparedness and reduced impacts in South Africa and the UK, contributing towards the foundations of a stable economy, a key milestone in the UK Governments Plan for Change and is vital to ensuring the United Kingdom remains resilient and responsive in the face of potential future shocks. This work is also helping to improve the reputation of the UK for delivering cutting edge advances to strengthen the quality of UK science, technology, research and innovation. It is strengthening skills in machine learning and AI techniques that can be applied to the UK and in other countries where UK partners are working.



Dr Nefeli Makrygianni, Scientist in the Met Office Marine Applications team said, *"This work involved close collaboration by scientists from the Met Office and SAWS to fully understand the challenges posed by load shedding events, and to initiate the development of foundational support systems for a more resilient energy grid and a growing renewable energy sector in South Africa, ultimately benefiting the South African economy."*

Henerica Tazvinga, Lead Research Scientist for Energy Applications at the South African Weather Service (SAWS) said *"Through collaboration between South Africa and the UK, we have made good progress on the development of solar power forecasting. We are now focusing more on applications for wind power forecasting to further support the energy sector"*.

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